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Retrospective Analysis of Tracheotomies Before and During the Coronavirus Disease 2019 Pandemic: A Single-Center Experience

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ABSTRACT

Objective: In this study, we aimed to compare clinical features and outcomes of tracheotomies performed in our clinic before and during the COVID-19 pandemic, with a special focus on coronavirus disease 2019 (COVID-19) positive cases.

Methods: The adult tracheotomy procedures performed in our clinic between 2018 and 2021 were retrospectively included in the study. Demographic data, indications, intubation periods, complications, and survival data were retrospectively analyzed and compared for the periods before and during the pandemic, as well as between patients with and without COVID-19.

Results: In the years considered, 84 (58.7%) male and 59 (41.3%) female patients underwent tracheotomies performed by our surgical team, for a total of 143 patients. The mean age of these patients was 60.9 ± 17.2 years. The indications for tracheotomy were chronic illness requiring long-term intubation in 80 (55.9%) cases and prevention or treatment of upper airway obstruction in 63 (44.1%) cases. Four (2.8%) patients developed pneumothorax after the operation. While 86 patients were operated on during the COVID-19 pandemic (2020-2021), only 9 (10.5%) of them were polymerase chain reaction (PCR)-positive for COVID-19. No significant differences were seen between the periods before and during the pandemic regarding age, gender, indications, intubation period, complications, or survival data of the patients ($P > .05$). Likewise, no increased risk of complications or decreased survival was observed for patients with COVID-19 ($P > .05$).

Conclusion: According to our findings, the COVID-19 pandemic did not significantly affect the indications, complications, or survival rates of tracheotomies performed in our clinic. Tracheotomies may be performed safely even for patients with COVID-19 after taking the necessary precautions.

Keywords: Tracheotomy, tracheostomy, coronavirus disease 2019, prolonged intubation, upper airway obstruction

Introduction

Tracheotomy, or tracheostomy, is one of the most common procedures performed in otorhinolaryngology clinics and intensive care units (ICUs) worldwide.[1] Generally, conventional open surgical tracheotomy, whether bedside or in the operating room, is the primary choice of otorhinolaryngology doctors, while bedside percutaneous dilatation tracheotomy is the technique typical chosen by ICU specialists.[2-4] There are various classifications and indications for tracheotomy procedures. Mechanical ventilation needs necessitating long-term or permanent intubation, upper airway obstructions (UAOs), and pulmonary aspiration are among the most common indications.[5] Long-term oro/nasotracheal intubation may result in subglottic stenosis due to intubation or cuff pressure trauma. Prolonged irritation and trauma may cause inflammation, fibrosis, stenosis, and significant obstruction in the airway.[6,7] Tracheotomy may prevent these common complications. In addition, it reduces the anatomical dead space in the airway and may thus shorten the period of weaning from mechanical ventilation in critically ill patients.[8-10]

However, performing tracheotomy procedures has become more challenging in the case of patients confirmed to have Coronavirus disease 2019 (COVID-19) due to the risk of disease transmission to health-care providers through droplets or aerosols. A number of preventive measures have accordingly

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been recommended for tracheotomy procedures performed during the COVID-19 pandemic.[11,12]

Currently, there is considerable data in the literature regarding the potential benefits and complications of tracheostomy for COVID-19-positive cases. Nearly 10%-15% of the patients with COVID-19 pneumonia-related respiratory failure needed prolonged invasive mechanical ventilation.[13-15] Tracheostomy was shown to provide earlier weaning from mechanical ventilation for COVID-19 cases and early discharge from the ICU.[16,17] Likewise, survival was found to be higher in tracheostomized patients.[16] The need for sedation is another issue for COVID-19 cases who need mechanical ventilation.[18] Tracheostomy also reduces the need for sedation in these patients.[19]

In this study, we aimed to compare the timing, indications, and complications of tracheotomy procedures performed in our clinic before and during the COVID-19 pandemic, with a special focus on PCR-positive COVID-19 cases.

Methods

The conventional open-approach tracheotomy procedures of adults (>18 years of age) performed in the hospital of the Gazi University Faculty of Medicine before and during the COVID-19 pandemic (2018-2021) were retrospectively analyzed after obtaining approval from the Gazi University Ethics Committee (12.10.2021/01). Tracheotomy procedures performed by surgical teams from our Otorhinolaryngology Department were included. The patients' charts were retrospectively analyzed to obtain data on demographics, the timing and indications of tracheotomies, complications, and mortality. Comparisons were performed for operations before the COVID-19 pandemic (2018-2019) and during the pandemic (2020-2021). Individuals for whom tracheostomy was performed during a total laryngectomy operation were excluded from the study. In our clinic, informed consent is taken from all the patients undergoing any operation for the usage of their patient charts in retrospective studies. However, informed consent particularly for this study is not applicable due to the retrospective study design.

Surgical Procedure

All operations were performed in the operating room. Conventional open-approach tracheotomy was performed with a horizontal skin incision 2 fingers above the suprasternal notch. After lateral retraction of the strap muscles, the thyroid isthmus was retracted superiorly to expose the tracheal rings (isthmus division was rarely needed). A horizontal incision of 120°, followed by superiorly curled ends, was performed between the 2nd and 3rd tracheal cartilages (Figure 1). The tracheotomy was secured with a suture passing from the cut cartilage ends. Finally, tracheotomy cannula placement was accomplished following intubation tube removal.

Main Points

- To our knowledge, this is the first study reported in the literature retrospectively comparing tracheotomies performed before and during the COVID-19 pandemic.
- The indications for tracheotomy were chronic illness requiring long-term intubation in 80 (55.9%) cases and prevention or treatment of upper airway obstruction in 63 (44.1%) cases
- Four (2.8%) patients developed pneumothorax after the operation.
- According to our data, the COVID-19 pandemic did not significantly affect the demographics, indications, complications, and survival rates of tracheotomy cases.
- We did not observe an increased risk of complications or decreased survival in PCR-positive COVID-19 cases.

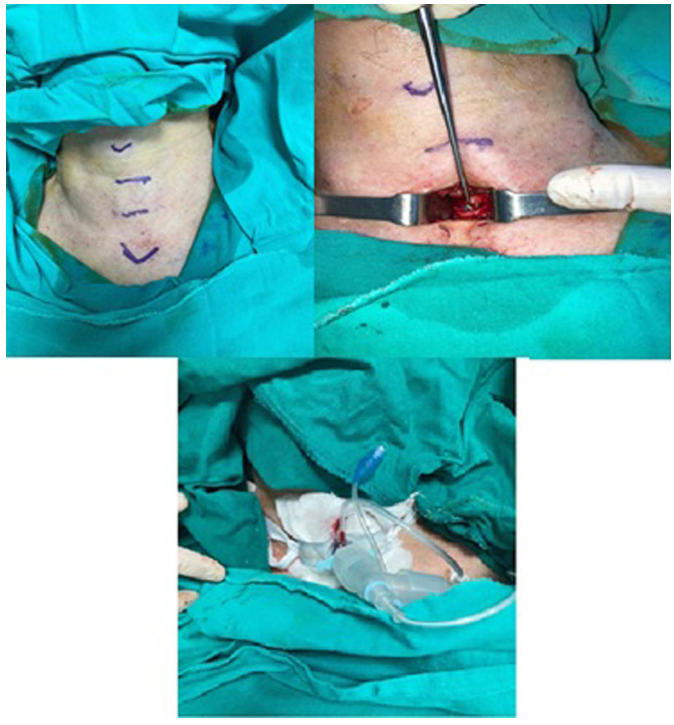

Figure 1. Neck skin and tracheal cartilage incision and cannula insertion during tracheotomy.

Perioperative Precautions During Tracheotomy Procedures in Cases of COVID-19

Negative pressure was maintained in the operating room. All members of the surgical team took appropriate barrier precautions (PPE masks, eye masks, etc.) (Figure 2). Mechanical

Figure 2. Precautions taken while transferring a patient with COVID-19 to the operating room.

ventilation was paused during the tracheal incision and tube insertion.

Statistical Analysis

IBM SPSS Statistics 22.0 (IBM SPSS Corp.; Armonk, NY, USA) was used for statistical analysis. Continuous variables were tested for normality with the Shapiro–Wilk test and histograms. Descriptive data were presented as mean ± standard deviation. The chi-square test was used to compare categorical variables. The Mann–Whitney *U*-test was used to compare continuous variables between two independent groups. Survival analysis was performed using the Kaplan–Meier test. Values of $P < .05$ were considered to be statistically significant.

Results

A total of 143 adult patients, including 84 (58.7%) males and 59 (41.3%) females, underwent tracheotomies in our clinic between 2018 and 2021. The mean age was 60.9 ± 17.2 (range 19-95) years. In our series, the indications for tracheotomy were found to be chronic illness necessitating long-term mechanical ventilation/intubation (CI) in 80 (55.9%) cases and UAO in 63 (44.1%) cases. Nine patients (11.3%) in the CI group underwent tracheotomy due to amyotrophic lateral sclerosis (ALS). In the CI group, the mean intubation duration before tracheotomy was 24.76 ± 14.8 (range 7-92) days. Nine patients (11.3%) underwent tracheotomy before 10 days had passed. The CI group also included 14 patients with aspiration and/or aspiration pneumonia. Subgroup analysis for the indication of UAO is shown in Figure 3. In the UAO group, prophylactic tracheotomy to prevent airway obstruction during major head and neck cancer surgery was the most common indication (n = 19, 30.2%), followed by UAO due to larynx carcinoma (n = 12, 19.1%).

The mean intubation period before tracheotomy for the CI group was 24.76 ± 14.77 days. The mean overall preoperative, postoperative, and total hospitalization durations were found to be 16.06 ± 24.68, 26.94 ± 25.96, and 48.03 ± 39.93 days, respectively. Hospitalization duration was significantly shorter in the UAO group, as shown in Table 1.

No significant differences were observed between data from before and during the COVID-19 pandemic (2018-2019 vs. 2020-2021) regarding age, gender, indications, tracheotomy timing, intubation period, or major complications of the patients (Table 2). Likewise, there was no significant difference in survival data of the patients before and during the COVID-19 pandemic, as shown in Figure 4a ($P = .284$). Among the 86 patients operated on during the pandemic, only 9 (10.5%) of them were PCR positive for COVID-19 perioperatively. No major complications were observed after the procedure in these cases. No significant difference was found between the survival rates for patients with and without COVID-19 ($P = .791$).

Complications

Four patients (2.8%) developed pneumothorax following tracheotomy. All of them underwent chest tube placement immediately after diagnosis. Two patients recovered completely. However, 2 deaths (1.4%) occurred after pneumothorax. One patient (0.7%) developed pneumo-mediastinum and recovered spontaneously without chest tube placement. One patient (0.7%) developed common carotid artery hemorrhage during the procedure, which was successfully primarily sutured without any neurological sequelae. One patient (0.7%) experienced accidental decannulation and was recannulated. Another patient (0.7%) experienced peristomal cartilage necrosis, which required minimal cartilage debridement. Peristomal hemorrhage from the incision or thyroid gland was the main minor complication (11 patients, 7.7%). Eight patients (5.6%) experienced peristomal infection. Six patients (4.2%) developed peristomal granulation tissue. One patient developed lymphedema.

Survival Data

The 12-month survival rates after tracheotomy before and during the COVID-19 pandemic were found to be 40.4% and 30.1%, respectively. No statistically significant difference was observed (Figure 4A). Furthermore, no significant difference was revealed between survival rates for patients with and without COVID-19 ($P = .791$) (Figure 4B). The 12-month survival rates were also compared according to tracheotomy indications. Patients with the indication of UAO were found to have

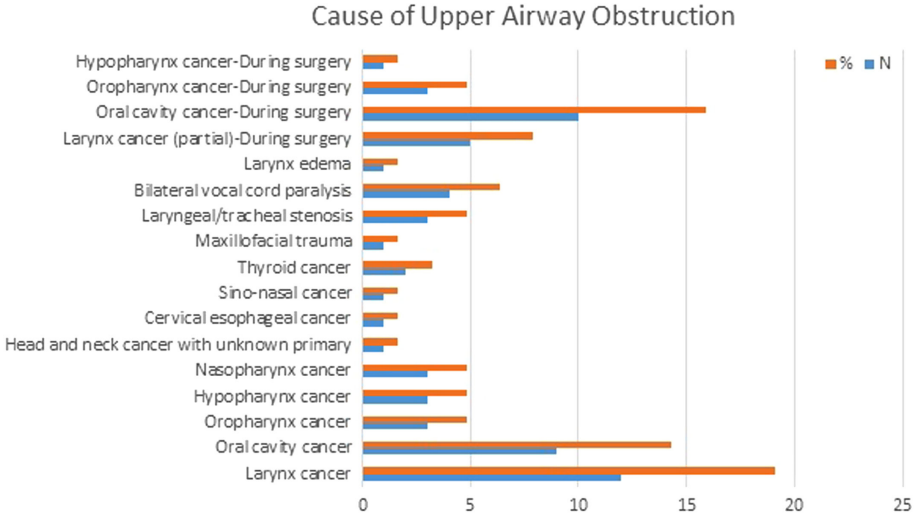

Figure 3. Subgroup analysis for upper airway obstruction indications for tracheotomy (tracheotomy performed during major head and neck cancer surgery aims to prevent possible postoperative airway obstruction and aspiration).

Table 1. Comparison of Hospitalization Duration in Days According to Tracheotomy Indication

	UAO (n = 63)			CI (n = 80)			
	Mean	SD	Minimum–Maximum	Mean	SD	Minimum–Maximum	*P**
Preoperative	3.9	8.15	0-71	31.43	26.28	1-116	<.001
Postoperative	13.62	16.02	0-88	37.43	27.51	1-112	<.001
Total	17.52	19.47	1-89	68.91	39.59	14-191	<.001

CI, chronic illness necessitating long-term mechanical ventilation; UAO, upper airway obstruction treatment or prevention.
*Mann–Whitney *U*-test.

significantly better estimated 12-month survival compared to those in the CI group (63.2% vs. 15.0%, $P < .001$) (Figure 4C). In the CI group, patients with ALS had better survival than the others ($P = .004$) (Figure 4D). Patients with aspiration pneumonia had a survival rate similar to that of the other patients ($P = .346$). Four patients underwent emergency tracheotomy, and no significant difference in survival rate was observed for those cases. Likewise, no significant difference was seen in the survival rates according to gender ($P = .477$). There were 9 patients with intubation periods of less than 10 days in the CI group. However, no significant difference was observed for survival rates according to intubation duration of <10 or ≥10 days ($P = .296$).

Discussion

There are various complications of tracheotomies, such as aspiration, subcutaneous emphysema, bleeding, infection, tube blockage by mucus plug, recurrent laryngeal nerve trauma, accidental tube removal, granulation around the tracheotomy site, tracheomalacia, pneumothorax, pneumomediastinum, esophageal perforation, and innominate artery fistula.[20-22] These complications may be classified as emerging in the early or late period. Among them, complications related to pneumothorax and innominate artery fistula causing mortality may be observed in the short term and the long term, respectively.[23-25] Pneumothorax is reported in the literature to occur in about 1% of tracheotomy cases.[26,27] In our series, 4 cases of pneumothorax (2.8%) were observed and 2 of those cases ended in death (1.4%). Routine lung x-ray radiography must be readily available after all tracheotomy procedures for the early diagnosis and treatment of pneumothorax.

In general, mortality most often occurs due to chronic illnesses present among tracheotomy patients. Engoren et al found the mortality rate for ventilator-dependent patients to be 57% in the first year following tracheotomy.[28] In our series, the estimated mortality rate in the first year was found to be higher in the CI group at 85%. In the CI group, ALS patients had better survival than the others ($P = .004$). Chio et al reported on 134 ALS patients who underwent tracheotomy, and they found a median survival duration of 253 days after the procedure.[29] The median duration of survival after tracheotomy for ALS patients was 12.7 months in our study. We did not observe any significant difference in the 12-month estimated survival rates after the procedure before and during the COVID-19 pandemic period (40.4% and 30.1%, respectively; $P > 0.05$).

Chronic illnesses necessitating long-term mechanical ventilation or intubation are currently the most common indications for tracheotomy.[1] Likewise, in our series, CI was found to be the most common indication. In the subgroup analysis of patients with UAO, prophylactic tracheotomy to prevent airway obstruction before major head and neck cancer operations was the primary indication. The survival rate of the UAO group after tracheotomy was significantly better than that of the CI group ($P < .001$), as expected. Likewise, Can et al compared mortality between tracheostomy indications; UAO and prolonged mechanical ventilation (PMV) groups, in a tertiary pediatric intensive care unit (PICU). After the tracheostomy procedure, all patients were alive in the UAO group (9 cases), whereas 23 patients (42.6%) in the PMV group (54 cases) died in PICU or after discharge from PICU.[30] Aksoy and Ocaklı compared survival ratios after tracheostomy among CI patients.

Table 2. Comparison of Demographics, Indications, and Complications of Tracheotomies Before and During the COVID-19 Pandemic (2018-2019 vs. 2020-2021)

	Before COVID-19 Pandemic		During COVID-19 Pandemic		
	n	SD	n	SD	*P*
Gender	37 M/20 F	–	47 M/39 F	–	.222
Age, years	59.4	16.3	61.8	17.8	.410
Intubation duration in days before tracheotomy	21.6	12.4	26.2	15.7	.272
CI indications for tracheotomy	27 (47.4%)	–	53 (61.6%)	–	.094
UAO indications for tracheotomy	30 (52.6%)		33 (38.4%)		
Elective/emergency tracheotomies	56/1	–	83/3	–	.538
Major complications	4/57 (7.0%)		4/86 (4.7%)		.547
Hospitalization duration in days after tracheotomy	22.0	21.3	30.2	28.2	.064

CI, Chronic illness necessitating long-term mechanical ventilation; UAO, upper airway obstruction treatment or prevention.

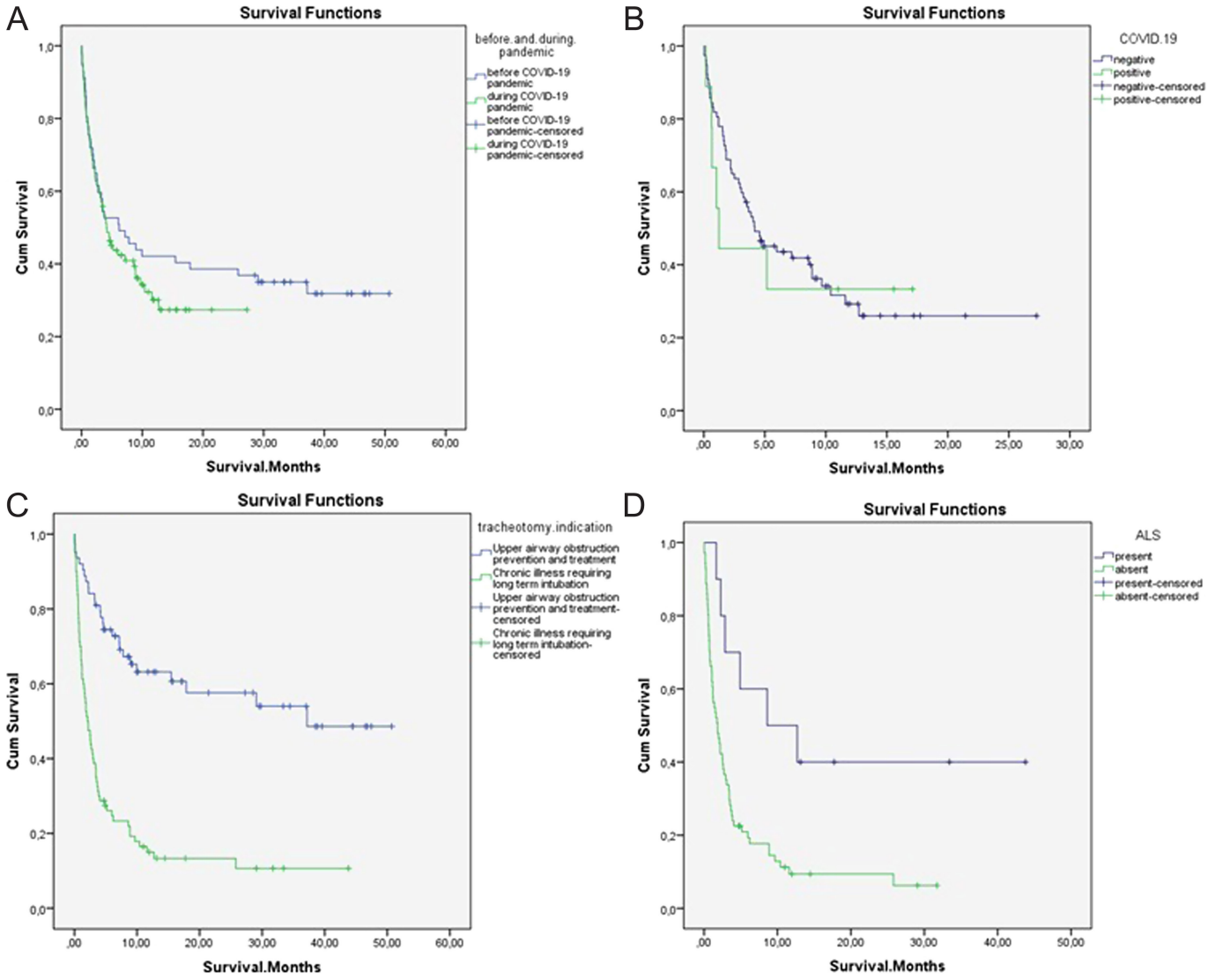

Figure 4. A-D. Comparison of estimated survival rates after tracheotomy with Kaplan–Meier survival analysis. A. Before and during the COVID-19 pandemic. B. Patients with and without COVID-19. C. Between UAO and CI groups. D. Between ALS and other patients in the CI group.

They have found that individuals with COPD have better 3-year survival rates compared to patients with heart failure and cerebrospinal disease.[31] In our study, patients with ALS had better survival than the others (COPD, heart failure, etc.) in the CI group, as mentioned above ($P = .004$).

The timing of tracheotomy is controversial. There are various suggestions in the literature for the tracheostomy timing as being 7, 10, 14, and 21 days after endotracheal intubation for adults.[32] There are many studies in the literature suggesting potential benefits of early tracheostomies on ICU stay time, mechanical ventilation duration, complications, and mortality.[33] However, contradictory studies are also published.[34] In multidisciplinary guidelines, including recommendations for tracheotomy during the COVID-19 pandemic, tracheotomy was not advised before 10 days.[11,12] In our series, the mean intubation period before tracheotomy for the CI group was found to be 21.6 ± 12.4 and 26.2 ± 15.7 days before and during the COVID-19 pandemic, respectively. Thus, there was a slight insignificant increase in the total intubation period before tracheotomy during the pandemic ($P > .05$). This nonsignificant change may be attributed to concerns of disease transmission during the procedure.

For patients with COVID-19, special techniques such as negative pressure operating rooms are applied to prevent disease transmission.[11,12] In our institution, patients who were PCR-positive for COVID-19 were accordingly operated on in a special operating room with negative pressure, and mechanical ventilation was paused during the tracheal incision and tube insertion. We performed tracheotomy procedures for 9 PCR-positive patients while taking the necessary precautions. No disease transmission was documented among the operating room staff after those procedures. In addition, no complications due to tracheotomy were observed in these cases. In a prospective cohort of 100 tracheotomies performed for patients with COVID-19, no disease transmission was observed among health-care workers involved in their care.[16]

In the current study, we also aimed to compare tracheotomies performed before (2018-2019) and during (2020-2021) the COVID-19 pandemic, as well as the results of tracheotomies performed for patients with and without COVID-19 during the pandemic. According to our data, there were no significant differences regarding age, gender, indications, intubation duration, or major complications of tracheotomies performed

during the pandemic compared to the years before the pandemic. Likewise, no significant difference was observed in survival rates or complications between patients with and without COVID-19 during the pandemic. However, Mesalles-Ruiz et al compared 67 tracheostomized non-COVID-19 patients with 64 tracheostomized COVID-19 patients. Hemorrhage complication was more common in COVID-19 patients (20.31%) compared to non-COVID-19 patients (5.97%).[35] In a prospective observational study conducted by Breik et al, the 30-day survival rates of COVID-19-positive patients requiring mechanical ventilation were compared. Higher survival rates were obtained for tracheostomized patients.[16] Yee et al compared COVID-19 positive and negative cases undergoing tracheostomy for prolonged intubation in ICU during the pandemic. They have compared weaning and ICU stay duration and mortality rates. No significant difference revealed between COVID-19-positive and -negative cases.[36] Likewise, Todi and Ghosh reported no significant difference in terms of mortality rate after tracheostomy for COVID-19-positive and -negative cases.[37]

The major limitation of our study is its retrospective design. In addition, the relatively small number of tracheotomies performed for patients with COVID-19 may be considered a limiting factor for the comparisons in our study. During the pandemic, only 9 (10.5%) patients undergoing tracheotomies in our clinic were PCR-positive for COVID-19. This may be attributed to the delay in tracheotomy procedures for longer than 14 days for COVID-19 patients based on early recommendations.[11,12,38] However, Kwak et al studied the outcomes of early tracheostomy (<10 days) for patients with COVID-19. According to their findings, early tracheostomy results were better than those obtained with delayed tracheotomies.[39]

To our knowledge, this is the first study reported in the literature retrospectively comparing tracheotomies performed before and during the COVID-19 pandemic. According to our data, the COVID-19 pandemic did not significantly affect the demographics, indications, complications, and survival rates of tracheotomy cases in our clinic. We did not observe an increased risk of complications or decreased survival in PCR-positive COVID-19 cases. In conclusion, tracheotomies can be performed safely even for PCR-positive cases during the COVID-19 pandemic after taking the necessary precautions and being prepared for possible complications.

Ethics Committee Approval: This study was approved by the Gazi University Ethics Committee (Approval no: Date: 12.10.2021/01).

Informed Consent: N/A.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – M.D., M.S., Y.K.K.; Design – M.D., M.S., Y.K.K.; Supervision – M.D., S.C., M.M.Ş., R.K., Y.K.K.; Resources – M.D., M.S., S.C.; Materials – M.D., M.S., M.M.Ş., R.K.; Data Collection and/or Processing – M.D., M.S., S.C., M.M.Ş., R.K.; Analysis and/or Interpretation – M.D., M.S., S.C., Y.K.K.; Literature Search – M.D., M.S., M.M.Ş., R.K., Y.K.K.; Writing – M.D., M.S., S.C., M.M.Ş., R.K., Y.K.K.; Critical Review – M.D., S.C., Y.K.K.

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